

Composite Panel Development at JPL

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Parametric computer studies can be used in a cost effective manner to determine optimized composite mirror panel designs. To this end JPL has created an InterDisciplinary computer Model (IDM) to aid in the development of high precision reflector panels for LDR. The materials properties, thermal responses, structural geometries, and radio/optical precision are synergistically analyzed for specific panel designs. Promising panel designs are fabricated and tested so that comparison with panel test results can be used to verify performance prediction models and accommodate design refinement. The iterative approach of computer design and model refinement with performance testing and materials optimization has shown good results for LDR panels. These panels must maintain their RMS surface figure to the one micron level.

The JPL IDM analysis is an innovative systems approach using a balanced interplay of state-of-the-art analysis tools (NASTRAN, TRASYS, SINDA, HAVOC, Mini-Optics) from several technology disciplines (see FIGURE 1). Sophisticated detailed analytical models designed by specialists are interfaced via a system superstructure that coordinates processing and the flow of data. This superstructure uses a generalized format that allows the substitution or modification of analysis modules without any major reprogramming effort. This has facilitated the prediction of the performance of LDR panels in different test chamber environments, orbits, and orbital configurations (single panel, panel arrays). The IDM can also be run in a semi-automated mode that allows the examination of intermediate stages of the analysis, and the interjection of various test data where appropriate. This facilitates the focus of specific sensitivity and optimizations studies.

Materials Module

An advanced materials model (HAVOC) is currently under development at JPL, and will be used to analyze the composite panel facesheets. Single ply and laminate composites can be optimized for mechanical, thermal, and optical properties. Three dimensional analyses can be performed in a statistical manner. The module is easy to use and has a built-in materials database.

Thermal Module

The panel configuration and thermo-mechanical properties from the materials module are input into the thermal module. Thermal loading is simulated by a specialized test environment and on-orbit (TRASYS) models. The thermal analyzer (SINDA) is then used to determine the panel's thermal response and temperature profiles.

Structures Module

The structures model (MSC/NASTRAN) incorporates the configuration, materials properties, thermal material response, temperature profiles, and panel geometry into a structural analysis that determines thermally induced surface displacements.

Optics Module

Panel surface displacement contours are optically characterized by using Zernike polynomials. JPL's Mini-Optics model was patterned after University of Arizona's FRINGE program. RMS surface and specific optical figure errors such as defocus, astigmatism, spherical aberration, and coma, along with radio telescope performance parameters, Strehl ratio, and diffraction limit are output as contours, profiles, graphs, and tables. All data is formatted so that direct comparison can be made with test performance data.

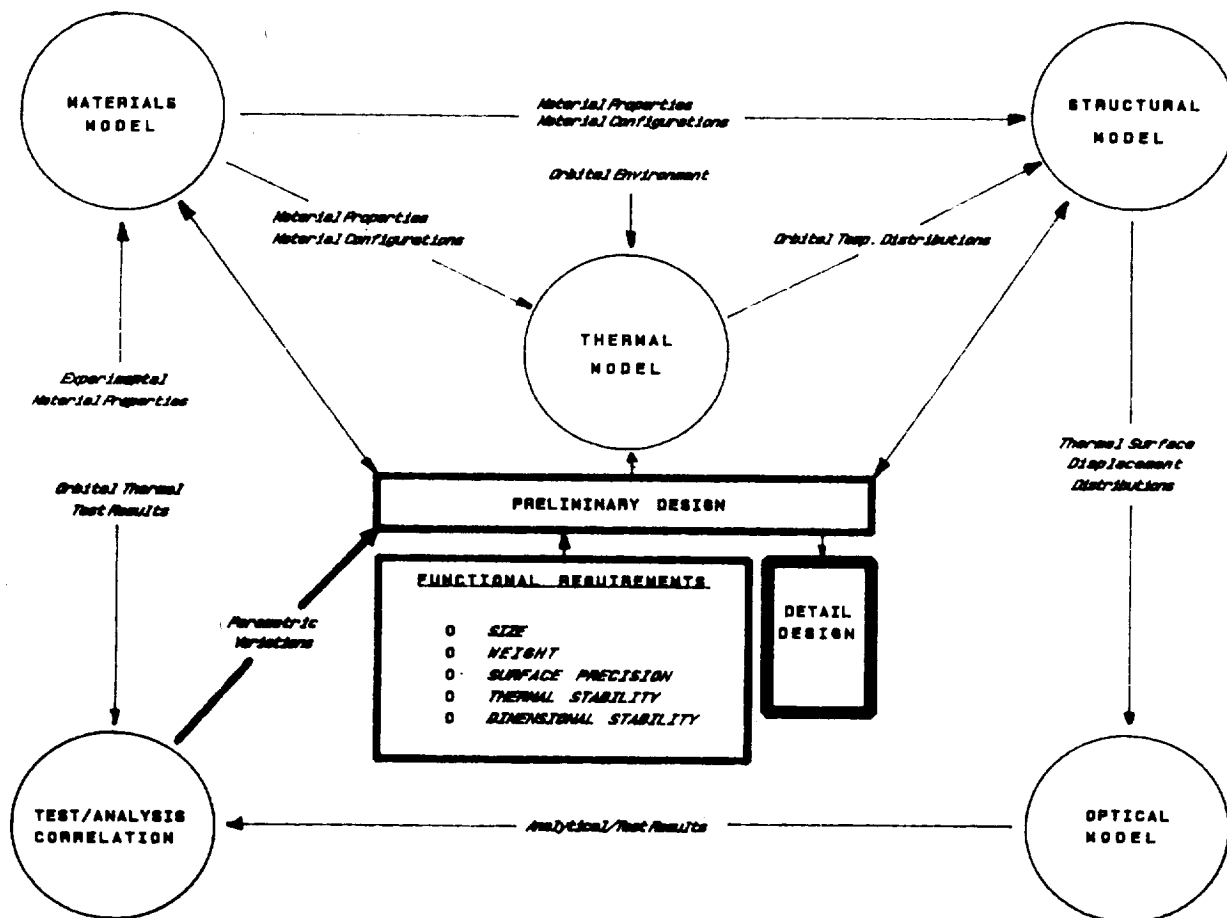


FIGURE 1. Composite Panel Development